Project Introduction

This project aims to explore high OPR (>60) Turbofan engines and HGEP (Hybrid Gas-Electric Propulsion) using counter-flow heat-pipe airfoils (including oscillating heat pipes) with nanofluids as the working fluid instead of alkali metals and by using fuel and the bypass stream as heat sinks. This is a novel concept with strong industry interest. Industry studies have shown that conventional turbofan engine architecture is not capable of improvement beyond a compressor overall pressure ratio (OPR) of 60 due to lack of cooling margins for the turbine and high temperatures in the aft compressor stages. For hybrid gas electric propulsion (HGEP) thermal management for MW-size motors is a major barrier. The goal of this project was to evaluate the feasibility (considering safety, sfc, heat capacity and weight) of heat pipe cooling for jet engines using organic nanofluids as the working fluid to alleviate concerns related to liquid metal heat pipes.

Anticipated Benefits

One minute per flight is globally equivalent to 4.8 tons of CO_2 added to the atmosphere per year. Aviation accounts for $1.5T of U.S. economic activity and has generated a positive trade balance of $78.3B in 2014 and supports 11.8M jobs. The aviation industry is set to expand and thus CO_2 emissions are set to rise unless aggressive CO_2 emission reduction goals are met. One way to achieve this is to reduce fuel burn by improving the efficiency of gas turbine engines by increasing the OPR. This cannot be achieved using conventional technology due to the high turbine temperatures that would arise. For gas turbine engines heat pipes have never been used due to constraints in manufacturing, heat transfer and safety concerns (alkali metal leakage). In 5-10 years - advance turbine technology to higher OPR in the short term. In 10-20 years - enable thermal management for electric motors and hybrid gas electric architectures. Heat pipes have been studied and used for application in Sterling engines for in-space application and there is an existing infrastructure to develop heat pipe or related technology for aeronautics.
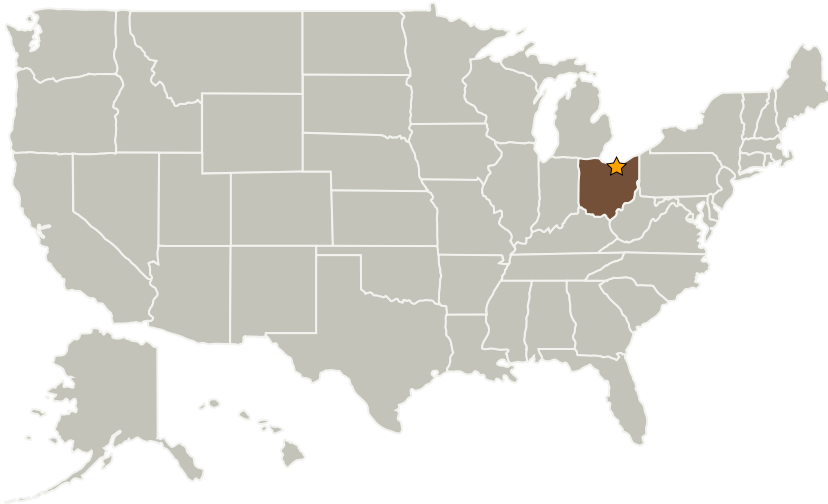

FY17 GRC: Tuna-Inspired Heat Pipe for High OPR Gas Turbines

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Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
⭐Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
General Electric Global Research	Supporting Organization	Industry	Niskayuna, New York
Purdue University-Main Campus	Supporting Organization	Academia	West Lafayette, Indiana

Primary U.S. Work Locations
Ohio

Project Transitions

▶ **May 2017:** Project Start

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Center Independent Research & Development: GRC IRAD

Project Management

Program Manager:

Gary A Horsham

Project Manager:

Vikram Shyam

Principal Investigator:

Vikram Shyam

Co-Investigators:

Isaiah M Blankson
Scott M Jones
Paht Juangphanich

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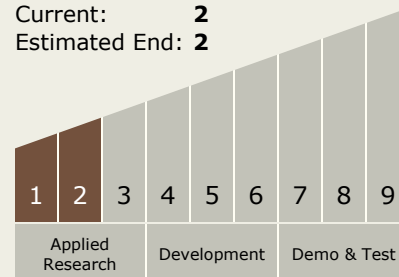https://techport.nasa.gov/view/94190

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November 2017: Closed out

Closeout Summary: The exploration of innovative approaches toward the development of more efficient technologies will continue to be of interest.

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**

1	2	3	4	5	6	7	8	9

Applied Research	Development	Demo & Test

Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.3 Aero Propulsion
    └ TX01.3.5 Turbine Based Jet Engines

Target Destination
Earth

Supported Mission Type
Push